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(54) **Consumer model**

(57) A model of consumer behaviour in a transaction environment such as customers moving around a bank branch, is generated from an artificial life algorithm to create a number of agents. In each agent, a genetically encoded drive, equivalent for example to hunger, is defined so as to correspond to a transaction need such as the need for cash. Interaction rules, such as navigation rules, are set for interaction between the agents and a first representation of an environment, and the program is run and the agents observed, then compared with real human behaviour. The best matched agents are selected and the program run again, the steps being repeated until a required level of comparison with real behaviour is reached.

The model can then be used with different transaction environments to study customer behaviour and to select the best branch layout or the like.

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Description

This invention relates to a method of generating a simulation model of consumers in a transaction environment, such as the behaviour of customers in a bank branch.

5　　Conventionally, a computer-based model of the behaviour of consumers in a transaction environment is built by an expert using a combination of education (incorporating at least part of the previous model) and experience (altering a previous model or creating a new model). The expert selects and programs-in the characteristics of consumer behaviour.

As transaction business, especially financial transaction business, becomes more complex, such models must

10　　also become more complex, and therefore difficult and time consuming to create. Even a model of queuing behaviour, which is merely one factor in a transaction business, is complex to generate.

It is the object of the invention to provide an improved method of creating a model of consumer behaviour in a complex environment.

According to the invention a method of generating a model of customer behaviour in a transaction environment,

15　　characterized by the steps of:-

selecting a software development tool incorporating at least one artificial life algorithm and capable of constructing a plurality of agents each having at least one drive;

defining at least one drive for each agent which is to be matched to a transaction-related need;

20　　and genetically encoding the defined drives

Artificial Life or "Alife" was defined by Langton in 1992 as published on http://lslwww.epfl.ch/~moshes/ alife.html-"a field of study devoted to understanding life by attempting to abstract the fundamental dynamical principles underlying biological phenomena, and recreating these dynamics in other physical media - such as computers - making them

25　　accessible to new kinds of experiment manipulation and testing.

In addition to providing new ways to study the biological phenomena associated with life here on Earth, life-as-we-know-it, Artificial Life allows us to extend our studies to the larger domain of "bio-logic" of possible life, "life-as-it-could-be..."

The drives in Alife systems include hunger, the need to sleep, and the wish to reproduce etc.; within the models,

30　　a drive reduction leads to a positive reinforcement in an agent.

In the method according to the invention, at least one such drive is specified and genetically encoded to equate to a consumer need in a transaction environment. Examples include the need for cash, or the need to make a deposit, in a financial transaction environment. Applications in retail or other interactive environments are also possible.

In the method according to the invention, a number of agents are created, each having a plurality of drives and

35　　sensors; interfaces are defined between the agents and a representation of a physical environment which is sensed by the sensors, and in which the agents make transactions; for example navigation rules are made which prevent any agent from moving through a wall.

In this specification "agents" means computational systems which inhabit dynamic unpredictable environments.

Also according to the invention, a number of agents is created, for example eight or more, but usually several

40　　hundred; the model is run, and, as is known in Alife modelling, a fitness function is applied by which a percentage of the agents is selected which best correspond to observed behaviour in real life. In the invention, the agents are selected which best match the observed behaviour of humans, for example in a bank branch.

As the model is run, the agents may reproduce or randomly mutate or may remain unchanged; the application of the fitness function may be applied several times until a required number of agents is available which all match actual

45　　customer behaviour to within predetermined limits.

It is an advantage of a model according to the invention that a full model of each human customer is not required; only the inputs which affect the behaviour of a human in a financial transaction, or other selected, environment are required as inputs.

After creation, the model can be constantly updated by comparison with newly derived information about real

50　　human customers.

After creation, the model can be used to predict behaviour in different environments, such as different bank branch layouts.

The invention will now be described by way of example only in greater detail, including by reference to Fig.1 which illustrates an architecture of "brain" for an agent in a model according to the invention.

55　　One suitable basis for a model according to the invention is for example the software development tool supplied by the company CyberLife Limited under the name Gaia.

In the first step of providing a model of customer behaviour in a bank branch, in each agent created by the software tool, at least one genetically encoded drive is programmed as a specified attribute or characteristic to correspond to

one of the consumer drives listed in table 1.

Table 1

Need for cash
Need for balance information
Need for mortgage
Need for loan
Need to make deposit
Need for statement
Need for satisfaction
Social needs (interactions)

Reduction of a drive gives positive reinforcement to that agent, as with the biological equivalent; for example if need for cash is made equivalent to hunger, then getting cash is equivalent to eating and provides positive reinforcement of action as a desirable drive reducer.

Initially the model is constructed to have a few hundred agents. As is known in Alife algorithms, each agent is also provided with at least one sensor and in this application each sensor is programmed to sense a physical object representation or object attribute relating to a bank branch. These physical attributes are listed in table 2, which also lists the attributes of each object.

Table 2

Physical Object	Object Attributes
ATMs	Colour size (height,
Table	width, depth,)
Pot Plant	Machine
Person	Texture
Tellerstation	Speed/direction
Noticeboard	Sound
Sign	
Television	
Paper	
Chair	
Personal computer	
Walls	
Door	
Partition	
Writing area	
Queue system	

It will be seen that physical objects include objects with which an agent must not physically overlap, such as a wall; objects with which an agent may need to interact, such as ATM; and objects to which special rules apply, for example a queue - the agent must join the end of the queue.

The physical objects are arranged to correspond to a real-life bank branch in which real customer movements have been recorded by some method which will be described later.

The model constructed from the software tool is then run for a period during which the initially-programmed agents (the first population) interact with the physical objects; some agents may mutate or reproduce or both and after a period a second population will be available. As is conventional in use of Alife algorithms, a fitness function is then applied. The behaviour of the second population is tested against the observed behaviour of humans in a bank branch, on a one-to-one basis, i.e. one agent to one observed human.

Such human behaviour may be observed by video cameras in a real bank branch, and their movements between tellers, ATMs, notice boards etc. may be tracked as a vector of coordinates for each human. Such vectors can then be compared with vectors of coordinates corresponding to each agent in the model.

In an alternative method, Markov models are generated on real data and the simulated data, as is conventional in animal behaviour studies, in which movements and actions are broken down into a fixed number of categories; the

real and simulated examples are then compared.

After application of the fitness function, the 50% of the agents providing the best fit are selected - this 50% may include both original agents and mutants or offspring, and the remaining 50% are culled.

The steps of running the model and applying the fitness function are applied several times, until a population of agents is available which matches actual human behaviour in the real bank branch to within predetermined limits; the number of agents should be sufficient to provide a good overall model of customer behaviour.

This final population of agents now forms a simulation model which may be used to test the effect of changes in branch layout by changing the physical attributes, for example providing more ATMs, fewer human tellers, a different layout, new advertising materials etc. The model may be run in coordination with several different layouts and the best layout selected, for example one which provides minimum waiting time, greatest customer satisfaction etc depending on the objective. Factors which can be evaluated are set out in table 3.

Table 3

Customer movement within the branch: where customers go, in what order they visit different physical attributes

Queuing: how queues form, queue length

Branch throughput measures such as Number of Bodies, Number of Transactions, Transaction Value

Branch evolution: the simulation model will allow different branch layouts to be evaluated

Customer satisfaction: as a customer moves through the branch, measures are taken of how the task are performed and used to indicate level of satisfaction; for example if there are no queues and the task is completed quickly there will be high consumer satisfaction; taking all consumers together will give an overall measure of how a branch performs for its customers.

Information Transfer from Advertising: the position within the branch of advertising boards can be selected depending on how many customers stop at a board and for how long (e.g. long enough to read it).

One important factor of an agent in a model according to the invention is the sensor which allows the agent to sense and interact with the "physical" environment. One possible sensing arrangement is illustrated in Fig.1 and will be referred to as the "brain" of an agent.

The brain operates at several levels; a first level 10 is the external sensing level, at which a field of view FOV is defined. A second level 12 is provided with a number, in this case five, of feature detector neurons, and the features detected by level 12 are evaluated in a feature evaluation level 14. After evaluation, the relevance of the feature to the needs and drives of the agent is evaluated in level 16, and overall relevance or greatest relevance determined in level 18 on a "winner takes all" basis.

The feature determined as having greatest relevance is naturally within the field of view at level 10, but the agent must navigate so as to approach that feature; the brain has as level 20 a number of target selection lobes, spanning a substantial angle of possible directions of movement of the agent; similarly in level 22 a number of non-target selection lobes, spanning a similar angle, are provided to allow the agent to navigate around obstacles (?). Levels 20 and 22 together allow the selection of a change of direction of movement of the entity, for example towards its selected feature.

Level 24 is a heuristics layer, ensuring that the agents function in a sensible manner.

Between the relevance evaluation layer 16 and the feature detection neuron layer 12 there is an internal expectation loop 26 which acts to provide feedback.

Such a brain can be arranged to recognise the physical attributes listed in table 2, optionally in the form of a grammar an example of which is set out in table 4 below.

Table 4

Bank → door walls 3+ staff+ customers * fittings
fittings → furniture * servicepoint *
servicepoint → teller window I ATM
ATM → cash only I deposit I information I all
staff → teller I greeter I security I manager

Table 4   (continued)
where * is 0 or more
+ is 1 or more
I is 'or' i.e., teller window or ATM

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In addition to the essentially financial drives referred to above, each agent may in addition be provided with a drive corresponding to the need for human interaction (the agent prefers a human teller to an ATM) or to the need to maximize the satisfaction with services provided.

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As with all Alife models, several drives may need to be satisfied concurrently.

In addition to modelling a bank branch layout, a model according to the invention may be applied to other financial transaction environments, such as a loan agent environment, and other delivery channels can be modelled, for example telephone banking, internet banking etc. in which factors in the model would include channel availability, service time etc.

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Parallels will easily be drawn in services other than financial transactions, such as retail transactions.

Claims

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1. A method of generating a model of customer behaviour in a transaction environment, characterized by the steps of:-

   selecting a software development tool incorporating at least one artificial life algorithm and capable of constructing a plurality of agents each having at least one drive;
   defining at least one drive for each agent which is to be matched to a transaction-related need;

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   and genetically encoding the defined drives

2. A method according to claim 1, characterized by generating a representation of a transaction environment;

   generating a plurality of agents each having a drive corresponding to a transaction-related need and each

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   capable of interacting with the environment in accordance with predetermined rules.

3. A method according to claim 2, characterized by

   causing the agents to interact with said representation of a transaction environment;
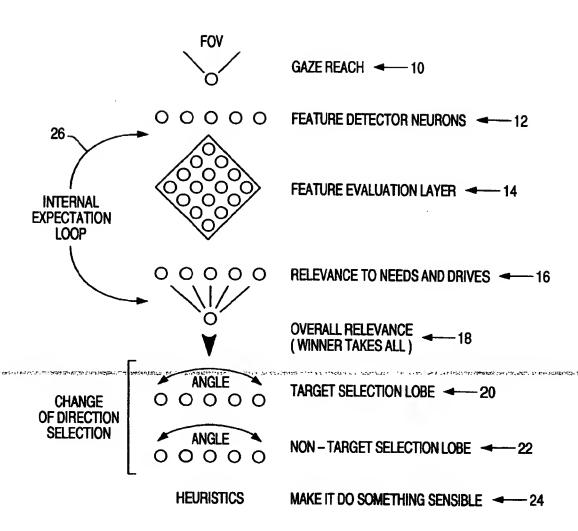
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   recording the interactions;
   comparing the interactions of each agent with the representation of the environment against real life interaction
   of humans with said transaction environment;
   and selecting a number of agents which provide the best comparison;

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4. A method according to claim 3, in which the comparing step, the selecting step and the interaction step are repeated until a required number of agents conform to a predetermined level of comparison.

5. A method of predicting and exploring potential patterns of customer behaviour, characterized by generating a model according to claim 4;

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   generating a representation of a different transaction environment;
   causing the selected agents to interact with said different representation;
   and observing the interactions

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6. A model of customer behaviour in a transaction environment generated in accordance of any one of claims 1 to 4.

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FOV

GAZE REACH ◄——— 10

FEATURE DETECTOR NEURONS ◄——— 12

26

INTERNAL
EXPECTATION
LOOP

FEATURE EVALUATION LAYER ◄——— 14

RELEVANCE TO NEEDS AND DRIVES ◄——— 16

OVERALL RELEVANCE
(WINNER TAKES ALL) ◄——— 18

CHANGE
OF DIRECTION
SELECTION

ANGLE

TARGET SELECTION LOBE ◄——— 20

ANGLE

NON – TARGET SELECTION LOBE ◄——— 22

HEURISTICS   MAKE IT DO SOMETHING SENSIBLE ◄——— 24

CAN LEARN NAVIGATION STRAEGY